the transmitters. It is in this stage of the transmission process that the message is susceptible to the enemy of all paging system designers: interference. In a receiver which is tuned into a frequency, interference is unwanted radio power, called noise, which exceeds the power of the wanted signal, thus obliterating that signal. Two types of interference affect the design of paging systems: intermodulation interference, which results from transmitters on other frequencies combining to produce excessive noise within the frequency of transmission; and co-channel interference, where excessive noise is created by other transmitters on the same frequency. Since the nature of radio wave propagation requires multiple transmitters to provide near-full coverage in a service area, interference is a real concern in the design of paging systems.

There are two methods of transmission used in paging systems to avoid interference. The first is sequential transmission, in which each transmitter is given a time slot in which it can transmit the message. Thus, while any one transmitter is being used, all other transmitters which could potentially interfere are turned off. This method has the advantage of being relatively simple to set up, but tends to limit the throughput (rate of data transmission) in the system. A more common method, especially in larger systems, is simulcast (or quasisynchronous) transmission. In this method, all transmitters are controlled do that all of their broadcast signals are essentially in synchronism. This synchronism can be achieved by equalizing the time it takes for the message to travel over the control link to each transmitter. An advantage of this transmission technique is that it results in much greater throughput.

The technology used for radio paging is not revolutionary, nor is it complex. In fact, paging is probably the simplest of all mobile communications applications. The very fact of its simplicity is what makes paging such a popular service, both from the provider's perspective and increasingly, from that of the consumer. For both groups, the simplicity of paging technology has one important consequence: lowered cost. Because of its technology, radio

paging will continue to be a cost-effective means of personal communications access.

III. The Competitive Environment

The demand for radio paging service is growing by leaps and bounds. According to the latest figures from the Telocator/EMCI report, there were 9.9 million paging subscribers in the United States at the end of 1990. What is most remarkable about that figure is that it represents a 22% increase over the previous year's total of 8.7 million subscribers. There are very few industries which can claim such impressive growth figures after more than 40 years of existence. Its rapid growth and relatively simple technology makes the paging industry an attractive alternative for companies wanting to offer a profitable communications service. This section will examine some of the major factors shaping the competitive environment for such companies.

FCC Regulation

As previously mentioned, paging's use of the radio spectrum places it under the regulatory auspices of the Federal Communications Commission (FCC). As compared to other personal communications industries, radio paging is not heavily regulated on the federal level. As an example for comparison, FCC rules applying to the cellular telephone industry clearly delineate service areas, and mandate a duopoly in each market, with one license reserved for the local telephone company. The FCC has not taken a comparably active role in the paging industry. Its primary responsibility in paging and any other communications service is to ensure that the public interest in reliable and effective service is met. In the paging industry, this translates to three specific responsibilities:

1. Allocation of radio spectrum;
2. Enforcement and adjustment of rules governing the use of spectrum for paging;
3. Licensing and regulating providers of radio paging service.

The source of the FCC's jurisdiction in this area is the Communications Act of 1934.

This act established the concept of radio spectrum management. The driving principle behind this approach was (and still is) that the radio spectrum is a limited natural resource. Since the demand for spectrum has always been much greater than the supply, the FCC's purpose has been to ensure that radio spectrum is efficiently utilized. For this reason, specific frequencies are set aside for the purpose of radio paging. Any company wishing to provide paging service must obtain a license from the FCC. This license grants permission to operate on a specified frequency channel (proposed in the application) in a specified service area. By accepting its license, the service provider agrees to abide by the rules governing the use of spectrum reserved for paging.

RCC/PCP Disparities

Despite its relatively passive regulation of the industry, the FCC has had an enormous impact on the structure of the paging industry. It has divided paging providers into two classifications for regulatory purposes, each falling under the jurisdiction of different parts of the rules and thus, under different Bureaus of the FCC. Paging providers are classified as either Radio Common Carriers (RCCs), regulated by Part 22 of the FCC rules and the Common Carrier Bureau, or Private Carrier Paging (PCP) operators, under the jurisdiction of Part 90 and the Private Radio Bureau. Each group of carriers is allocated separate frequencies, and each is subject to different regulations, but both types provide a service which is indistinguishable to the end-user. For a paging subscriber, the point is moot; no matter who is providing the service, the "beeper" still "beeps." For the providers, however, the distinctions between private and common carriage can have consequences which are quite relevant. Depending upon the market, the classification of the paging provider can have a potential impact upon the profitability of the service.

The legal distinction between PCPs and RCCs is rather abstract. There is no a priori condition to be met in order to qualify for private carriage. A private carrier is a carrier which

holds a license for a Part 90 frequency which is available for one-way paging services. In order to maintain its legal classification as a PCP, the carrier must segregate the costs of its interconnection with the telephone company, and offer it to its subscribers on a "pass-through" basis only. In other words, the interconnection can not be resold at a profit. Just about any RCC operator reading this would quite adamantly insist that they do not mark up the costs of their interconnection either. However, this fact does not confer upon RCCs the status of private carriage.

While this legal distinction might seem to have little real world relevance, the practical differences between private and common carriage are quite relevant. Originally, the classification of private carriers was designed to service small target groups with specialized needs: for example, hospitals and hotels. Common carriage by its very definition was designed to offer service to the public at large. While these original goals have been modified over time, the structure created to facilitate them has remained the same. In today's market, many PCPs compete directly against RCCs for subscribers, and the rules governing the two classifications make for inherent advantages and disadvantages depending upon the service classification.

Private carriage has a number of advantages designed to facilitate its service to specialized target groups. In the amendment to the Communications Act of 1934 which provided the legal definition discussed above, Congress preempted state regulation of PCPs. This frees PCPs from the state entry and rate regulation to which radio common carriers are subject. While many states do not regulate radio common carriers, this is a significant advantage in those states which do. Even those states which have policies which do not allow more than one RCC in a market are prevented by federal law from disallowing PCP operation within their borders.

PCPs are also subject to a much more liberal regulation on the federal level than are their RCC counterparts. The process for obtaining a PCP license in a given area is much shorter and less expensive than is the process on the RCC side of the fence. Part

can be obtained in about two months; the same process for an RCC might take six to eight months. Another difference in federal regulation is disparity in transmitter power and height limits. Private carriers are frequently authorized to operate at higher power levels than RCCs. They may generate levels over 3000 watts, whereas common carriers are generally limited, at least in their initial system construction, to a maximum of 500 watts. While common carriers face stringent limitations on the height of their towers, PCPs operating in frequencies below 900 MHz have no such limitations. The effects of these regulatory disparities were alleviated somewhat by an FCC rulemaking in 1990 which relaxed the power limitations for RCC system fill-ins.

These regulatory distinctions have historically created an inherent tension in the relations between RCCs and PCPs; this tension was brought to the surface in comments filed in response to the FCCs proposal in 1989 to alter the eligibility restrictions for PCP end-users. Up until that point, Part 90 had contained three eligibility restrictions which reflected the FCC's original intent to gear private radio towards specific target groups. PCPs were prohibited from offering service to any level of government or its agencies, foreign governments or their agents, and to individuals without a commercial application for the paging service. RCCs opposing any changes in these regulations argued that such changes would make PCPs de facto common carriers, while they still retained all of the benefits of PCP regulation. In January, 1991, the FCC lifted the restriction against service to government entities, leaving the other two restrictions intact. However, the prohibition against service to individuals is quite weak; any salesperson who can not convince an "individual" that he/she does not have a legitimate commercial use for paging service should probably consider another calling. Thus the FCC's decision opened up a potentially lucrative market, which includes fire and police departments, and took no action to strengthen the remaining restrictions.

Obviously, there are disadvantages to private carriage, otherwise there would be no reason to apply for RCC licenses. One substantial technical advantage of common carriage is

that Part 22 grants exclusivity of frequency within a market. For example, if Company A, an RCC, holds a license to operate a paging system on 152.70 MHz, it is guaranteed that it will be the only company operating on that frequency channel in that service area for the term of its license. Looking at Part 90, if Company X is operating on 152.48 MHz, it very well might be required to share the use of that frequency with Company Y and Company Z, and any other company which might want to come along and apply for 152.48 MHz. Moreover, the companies which share a frequency are required to work out non-interference sharing arrangements among each other. In systems operating on crowded PCP frequencies, this translates to waiting times of 5 to 10 minutes in placing calls, and limitations on system expansion.

Another significant advantage for RCCs, and a matter of much consternation for many PCPs, is the rate charged by the telephone company for interconnection. By the terms of an FCC Policy Statement in the early eighties, worked out in conjunction with the RCC community and the phone companies, RCCs are considered to be co-carriers, not end-users of the phone service, and thus are entitled to lower interconnection rates based on this status. PCPs were not included in this interconnection negotiation, and thus do not share the co-carrier designation. As a result, some private carriers pay interconnection rates that are considerably higher than those charged to RCCs. Because both RCCs and PCPs are providing identical services, PCPs see this issue in terms of a potential case of discriminatory pricing, but for the time being, phone companies are able to justify their pricing schemes by stating the obvious fact that PCPs are not RCCs. This remains an extremely contentious issue for PCPs, and an issue on which many RCCs are not inclined to give much sympathy.

The distinctions outlined above may give the impression that PCPs and RCCs are divided into two opposing camps. While this has been true at times in the history of the industry, it is not an accurate assessment of the current situation. Just to add some perspective to this discussion, it is worth noting that it is estimated that private carriers make up about 15% of

paging providers. While this statistic is not intended to diminish the importance of these carriers, it should indicate that the issues discussed above are not as fractious as they may appear. More importantly, that which joins common and private carriers is greater than what divides: the service which is being offered is identical. In fact, many companies which have multiple RCC licenses are beginning to obtain PCP licenses as well. This development is a reflection of a growing realization by RCCs that resources can be better spent in using private carriage to augment existing service, rather than in fighting the PCP industry. Instead of all out war in the paging industry, there is a growing sense of accommodation. In an industry which is consolidating at a rapid rate, the distinctions between PCPs and RCCs are blurring to a great extent. As this occurs, the potential for the distinctions to be lessened on the regulatory front will become more and more likely.

Wide Area/Nationwide Coverage

Another factor involved in the structure of the industry is the issue of coverage areas. When a company is granted a paging license by the FCC, that license, and the frequency allocation for which it is granted, may be utilized within the confines of a specified geographic area. This area is called a Reliable Service Area, and its parameters are defined by the specific details of the company's application, i.e. tower height, power output, number of transmitters, etc. Depending upon the location of the paging system, companies may need to expand their coverage beyond the confines of the Reliable Service Area. For example, a company offering paging in a rural area may have no need to offer an expanded service area, while a company which offered paging services in Washington D.C. would find its market rather limited if it was unable to offer service outside the city limits. For this reason, most companies offer some form of regional or even nationwide coverage.

The terms "wide area" and "nationwide" are somewhat amorphous. Wide area coverage can refer to service which covers two adjacent cities or an entire region (i.e. the northeast

corridor). Since almost all pagers operate on a single frequency, a company which wants to offer wide area service must hold the same frequency allocation in each market it wants to serve. This leaves the paging company with three options: it can apply to the FCC for additional licenses on the same frequency in adjacent markets, it can purchase the licenses from those who hold them, or it can try to work out some sort of traffic sharing arrangement. Since most of the frequencies reserved for paging are taken in major markets, the first option is usually not feasible. The second option, while much more feasible, also tends to be much more expensive. Traffic sharing arrangements are a potential solution, but produce less revenues than would result from one company holding both licenses. These three options for system expansion result in a variety of meanings for the term "wide area" coverage. For example, a company's claim to offer regional coverage between New York and Washington could mean a number of different things: the company might serve the major cities and their surrounding suburbs in this region, or it might serve the cities, suburbs, and the major highway which connects the cities, or it might offer some combination, serving some of the connecting areas between the cities, but not all.

The meanings for the term "nationwide paging" are even more varied. Companies which offer this type of service do not necessarily offer paging in every populated area of the U.S. Rather, the term "nationwide" is used somewhat ambiguously in referring to service which covers some large percentage of the population base. Since the primary market for this service is in the business sector, a company which covers a large number of major metropolitan areas, but not necessarily the areas in between, will often call its coverage "nationwide." The expense involved in obtaining identical frequency allocations and setting up systems to cover the entire U.S. population base precludes the possibility of a truly nationwide service. Companies offering such service make use of one of three different methods of covering a nationwide market: the acquisition of a nationwide frequency allocation, FM SCA (Subsidiary Carrier Authorization) broadcasting, and the linking of local or affiliate carriers.

In 1985, the FCC, anticipating that a market would exist for nationwide paging service and recognizing the difficulty of servicing such a market given the licensing requirements, set aside three frequency channels in the 931 MHz range for the exclusive use of nationwide paging. Thus, a company holding the license to one of these frequencies would have the same frequency allocation in any U.S. market in which it decided to set up transmitters. The three licenses were lotteried off to applicants which met certain minimum financial standards. The current holders of these licenses are as follows:

SkyTel: the nationwide paging subsidiary of MTel, SkyTel is the only original lottery winner which still holds its license, and the only nationwide license holder to have its system up and running as of the beginning of 1991. It is the dominant player in the nationwide industry. SkyTel covers over 180 major metropolitan areas in the U.S., and had over 85,000 subscribers at the end of 1990. It offers links to international markets as well, through its agreements with Canada, Singapore, and Mexico, and is working on an arrangement to provide paging for its customers travelling to Japan.

MobileComm: is a wholly owned subsidiary of BellSouth. Already one of the three largest carriers in the industry, with over 800,000 subscribers, MobileComm just recently obtained its nationwide paging license by buying out the lottery winner, CellTelCo, in April of 1991. The company is hoping to have its nationwide system up and running by the end of 1991, and is exploring the possibility of offering both digital and alphanumeric service. The mere fact of its size gives MobileComm good potential to generate subscriber numbers large enough to compete with SkyTel. It remains to be seen, however, to what extent MobileComm will be successful in convincing its current subscribers to switch over to the higher revenue nationwide service.

Motorola: by far, the largest supplier of pagers to the industry. It obtained its nationwide license by its purchase of Contemporary Communications Corporation, the license's previous holder, in September of 1990. Since Motorola is the large[illegible]

supplier to the industry, it is quite sensitive to the perception that it could be using its license to compete against its own customers. Thus, Motorola is not using its nationwide frequency for traditional paging services, but is establishing a nationwide network which will allow for wireless communications to computers (specifically laptops). The system, called EMBARC (Electronic Mail Broadcast to a Roaming Computer), is expected to be operational by the end of 1991. Motorola has already introduced its first product for the system, called the DataStream Advanced Information Receiver, for use with the Hewlett-Packard HP95LX Palmtop portable computer.

Companies which are not fortunate enough (or wealthy enough) to hold a nationwide license are not shut out of the nationwide market. Another method for providing nationwide service is by linking together affiliates or local carriers. A number of companies currently provide nationwide service in this manner. Two such companies, PageNet and Network U.S.A., use the same frequency allocation in all of their local operations, and link these through a central hub. Of these two companies, only PageNet is linking its own operations; Network U.S.A. signs up affiliates which operate on the 152.480 PCP channel. Another company which links affiliates is Telefind. This company differs in that its affiliates are not required to operate on the same frequency. To accommodate the differing frequencies, Telefind uses its Messager pager, which is a frequency agile receiver capable of scanning over 10,000 channels.

A third method of offering nationwide service, FM-SCA, is utilized by only one company: Cue Paging Corporation. The FM subcarrier technology does not use any of the frequencies that are allocated for radio paging. Instead, carriers using this technology lease a channel from an FM radio broadcaster. This channel is broadcast along with the radio signal, but is not picked up by radios. Paging service can be offered on this subsidiary channel. A benefit of this technology is that it gives Cue the benefit of increased broadcast signal strength, because FM radio towers are not subject to the height and power restrictions that face other

paging carriers. Critics of the technology claim that it limits the carrier's coverage to those areas that can be reached by the FM broadcaster, thus hampering the ability to "fill in" non-covered areas. Despite the debate over the merits of its technology, Cue continues to be moderately successful in offering both regional and nationwide service, with coverage in more than 200 metropolitan areas throughout the U.S.

Consolidation

The trend toward consolidation in the radio paging industry is becoming more and more pronounced. There are over 2,000 PCPs and RCCs in the U.S. today, but of that number a very small group control a large percentage of the total subscribers. To illustrate: the combined subscriber numbers of the top 20 paging carriers in the U.S. add up to over 40% of the 9.9 million units in service reported by the most recent EMCI/Telocator report on the paging industry. If that list were to be expanded by another 20 companies or so, the 40% market share would be much greater.

The enormous success of the paging industry over the past decade or so has been a major factor contributing to the trend towards consolidation. Over that time frame, the installed base of pagers has increased ten-fold, from 1 to 9.9 million. As the demand for paging has increased, it has outrun the resources of many "traditional" paging carriers. Many of these companies served a small area with just a few transmitter sites, and may have had a few hundred (or even less) pagers on the street. While there are still a large number of such companies, the increase in demand has favored the entry and expansion of large companies with the resources to serve a large market. Particularly fitting this description are the Regional Bell Holding Companies (RBHCs), which have been extremely aggressive in their acquisitions of paging companies. Of the top five RCCs, three companies are subsidiaries of an RBHC: MetroMedia Paging (Southwestern Bell), MobileComm (BellSouth), PacTel Paging (Pacific Telesis). A fourth company in the top 5, Graphic Scanning, was recently purchased by

BellSouth's MobileComm division.

Another factor which contributes greatly to the consolidation in the paging industry is the issue of regional and nationwide coverage discussed above. As Americans travel with increasing frequency, paging carriers are required to expand their coverage area to meet the needs of their customers. As noted above, there is great expense involved in system expansion. Thus, smaller companies which do not have the financial capabilities to expand systems are acquired by carriers with deeper pockets. The fact that most paging systems operate on only one frequency exacerbates this trend. A small company which holds a license in an area between two major markets which are served by another carrier on the same frequency finds itself in an optimal selling position. One other pressure for small RCCs to cash out is that they are increasingly losing control of the pricing scheme for their product to their larger, more efficient competitors. As a result of these trends, the small "mom and pop" paging carriers which made up a large percentage of the industry until the last decade or so are disappearing at a rapid pace.

Certainly, it seems clear that the paging industry is not at all stagnant. The important factors contributing to the industry's structure are evolving: FCC regulation is likely to become less onerous; the antagonisms between RCC and PCP carriers are breaking down; the needs of paging subscribers are becoming more regionally and nationwide oriented; and the industry as a whole is consolidating. These changes are all beneficial, and place the industry in a good position as it enters the 1990's, a period which may come to be known as the decade of wireless communications.